10. Recalculations and Improvements

Each year, emission and sink estimates are recalculated and revised for all years in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks,* as attempts are made to improve both the analyses themselves, through the use of better methods or data, and the overall usefulness of the report. In this effort, the United States follows the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance* (IPCC 2000), which states, "It is good practice to recalculate historic emissions when methods are changed or refined, when new source categories are included in the national inventory, or when errors in the estimates are identified and corrected."

The results of all methodology changes and historical data updates are presented in this section; detailed descriptions of each recalculation are contained within each source's description contained in this report, if applicable. Table 10-1 summarizes the quantitative effect of these changes on U.S. greenhouse gas emissions and Table 10-2 summarizes the quantitative effect on U.S. sinks, both relative to the previously published U.S. Inventory (i.e., the 1990 through 2004 report). These tables present the magnitude of these changes in units of teragrams of carbon dioxide equivalent (Tg CO_2 Eq). In addition to the changes summarized by the tables below, the following sources and gases were added to the current inventory:

- methane (CH_4) emissions from Ferroalloy Production;
- CH_4 and nitrous oxide (N_2O) emissions from Forest Land Remaining Forest Land to account for emissions from forest fires;
- CO_2 emissions from Silicon Carbide Production; and
- CH_4 emissions from Silicon Carbide Consumption.

The Recalculations Discussion section of each source presents the details of each recalculation. In general, when methodological changes have been implemented, the entire time series (i.e., 1990 through 2004) has been recalculated to reflect the change, per IPCC (2000). Changes in historical data are generally the result of changes in statistical data supplied by other agencies.

The following emission sources, which are listed in descending order of absolute average annual change in emissions between 1990 and 2004, underwent some of the most important methodological and historical data changes. A brief summary of the recalculation and/or improvement undertaken is provided for each emission source.

- *Agricultural Soil Management*. Changes occurred as a result of (1) modifying nitrogen (N) inputs to be consistent with the agricultural soil carbon (C) inventory, (2) modeling within county variation in soil characteristics and weather, and (3) incorporating revised methods and emission factors from IPCC (2006). Overall, changes resulted in an average annual increase in N_2O emissions from agricultural soil management of 90.4 Tg CO_2 Eq. (33 percent) for the period 1990 through 2004.
- *Net CO_2 Flux from Land Use, Land-Use Change, and Forestry*. Influential changes in the Land Use, Land-Use Change, and Forestry sector occurred in calculations for forest C stock and flux estimates. Changes for the period 1990 through 2004, as compared to the estimates presented in the previous inventory, are based on the cumulative effects of (1) incorporating additional state and sub-state inventory data, and (2) adjusting total stock estimates used in earlier years to account for inclusion or removal of different ecological community types in subsequent state and sub-state inventory years. Overall, these changes, in combination with adjustments in the other sources/sinks within the sector, resulted in an average annual decrease in net flux of CO_2 to the atmosphere from the Land Use, Land-Use Change, and Forestry sector of 37.7 Tg CO_2 Eq. (7 percent) for the period 1990 through 2004. However, the most consequential changes from these recalculations occurred in 1990, which saw a 197.4 Tg CO_2 Eq. (21.7 percent) decrease in sequestration.
- *CO_2 from Fossil Fuel Combustion*. The most important update that affected the historical estimates for CO_2 emissions from fossil fuel combustion was the change to the C oxidation factor for all fuel types to 100 percent.

This change was made according to IPCC (2006) and impacted emission estimates for all fuel types. Additionally, silicon carbide used for petroleum coke manufacturing was reallocated to the Industrial Processes chapter. Overall, changes resulted in an average annual increase of 36.9 Tg CO_2 Eq. (0.7 percent) in CO_2 emissions from fossil fuel combustion for the period 1990 through 2004.

- *Natural Gas Systems*. The inventory now contains estimates for non-combustion-related (vented, fugitive, flared) CO_2 emissions from the natural gas industry. The estimation uses the same activity and emission factors from the methane (CH_4) emission estimates but adjusts the emission factors for the ratio of CO_2/CH_4 content of the natural gas. Efforts were made to ensure that there was no double-accounting of CO_2 emissions from other system inventories in the overall Inventory. Overall, changes resulted in an average annual increase in CO_2 emissions from natural gas systems of 24.4 Tg CO_2 Eq. (376 percent) for the period 1990 through 2004.

- *Manure Management.* A few changes have been incorporated into the overall methodology for the manure management emission estimates. State temperatures are now calculated using data from every county in the state. Another major change in methodology was using climate-specific CH_4 conversion factors for dry manure management systems. The percentage of dairy cattle, swine, and sheep on each type of manure management system was also updated for the current inventory, based on farm size data from the 2002 USDA Census of Agriculture (USDA 2005e). Changes were also made to the current calculations involving animal population data. N_2O emission estimates from manure management systems have decreased for all years of the current Inventory compared to the previous inventory due to the use of updated emission factors from IPCC (2006). Overall, the changes resulted in an average annual decrease in N_2O emissions from manure management of 8.1 Tg CO_2 Eq. (47 percent) for the period 1990 through 2004.

- *Substitution of Ozone Depleting Substances.* An extensive review of chemical substitution trends, market sizes, growth rates, and charge sizes, together with input from industry representatives, resulted in updated assumptions for the Vintaging Model, which is used to calculate emissions from this category. These changes resulted in an average annual increase in hydrofluorocabon (HFC) and perfluorocarbon (PFC) emissions from the substitution of ozone depleting substances of 7.6 Tg CO_2 Eq. (21 percent) for the period 1990 through 2004.

- *N_2O Emissions from Wastewater Treatment.* For N_2O emissions from domestic wastewater, a minor change made to the time series was to include more specific estimates of the percent of U.S. population that uses centralized wastewater treatment. Also, a factor was introduced to account for the amount of biological denitrification used at centralized treatment plants. The calculation estimates for protein consumed were updated for the entire time series. Additionally, the default factor for N_2O emissions from N in effluent discharged to aquatic environments was updated from 0.01 to 0.005 kg N_2O-N/kg sewage-N. Overall, the changes resulted in an average annual decrease in N_2O emissions from wastewater treatment of 7.5 Tg CO_2 Eq. (51 percent) for the period 1990 through 2004.

- *Landfills*. For municipal solid waste landfills, changes to historical data resulted from the application of a more accurate integrated form of the first order decay model, and incorporating a delay time of 6 months. Another improvement was made in the estimate of CH_4 generation from industrial landfills, which was based on industrial production, waste disposal factors, and the first order decay model. Additionally, EIA, LMOP, and flare vendor databases were updated, affecting estimates of CH_4 recovery. Overall, changes resulted in an average annual decrease in CH_4 emissions from landfills of 7.5 Tg CO_2 Eq. (4.9 percent) for the period 1990 through 2004.

- *CH_4 Emissions from Wastewater Treatment.* Two methodological refinements and one major data change resulted in a decrease in CH_4 emissions from wastewater treatment for the period 1990 through 2004 relative to the previous inventory. First, the current estimates are based on four distinct source categories (septic systems, centrally treated aerobic systems, centrally treated anaerobic systems, and anaerobic digesters), whereas in previous inventories, emissions were calculated based on an overall percentage of anaerobically treated wastewater. Calculating emissions from anaerobic digesters constitutes the second methodological refinement to this category. The major data adjustment involves the Biochemical Oxygen Demand (BOD) per capita rate. The current estimates employ a standard value for the BOD per capita rate across the time series (0.09 kg/capita/day). For industrial wastewater, production data for the entire time series were updated and other factors such as wastewater outflow, BOD, and percent of waste treated anaerobically, were revised. Overall, changes resulted in an average annual decrease in CH_4 emissions from wastewater treatment of 5.6 Tg CO_2 Eq. (16.7 percent) for the period 1990 through 2004.

- *Wood Biomass and Ethanol Consumption.* Commercial wood consumption values were revised for the full timeseries, based on updated information from EIA's Commercial Building Energy Consumption Survey (EIA 2006). EIA (2006) also reported minor changes in wood consumption by the residential and industrial sectors for the full timeseries, and in ethanol consumption for 2001 through 2004. Overall, changes resulted in an average annual increase in emissions from wood biomass and ethanol consumption of 2.9 Tg CO_2 Eq. (1 percent) from 1990 through 2004.

Table 10-1: Revisions to U.S. Greenhouse Gas Emissions (Tg CO_2 Eq.)

Gas/Source	1990	1995	2000	2001	2002	2003	2004
CO_2	**56.4**	**59.3**	**75.6**	**47.9**	**76.9**	**75.0**	**76.5**
Fossil Fuel Combustion	27.6	33.3	51.2	24.8	55.5	53.4	56.5
Non-Energy Use of Fuels	0.1	0.4	0.3	0.3	(1.2)	(2.2)	(3.2)
Natural Gas Systems	27.9	24.8	23.6	22.7	23.4	22.4	22.2
Cement Manufacture	NC	NC	NC	NC	NC	NC	+
Lime Manufacture	+	+	+	+	+	+	+
Limestone and Dolomite Use	+	NC	NC	NC	NC	NC	NC
Soda Ash Manufacture and Consumption	NC	NC	NC	NC	NC	NC	NC
CO_2 Consumption	0.6	0.6	0.5	+	+	+	+
Municipal Solid Waste Combustion	+	+	+	(0.3)	(0.3)	0.1	0.8
Titanium Dioxide Production	NC	NC	NC	NC	NC	NC	NC
Aluminum Production	(0.2)	(0.2)	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)
Iron and Steel Production	+	+	(0.1)	0.2	0.2	0.2	0.2
Ferroalloy Production	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Ammonia Production and Urea Application	NC	NC	+	+	(0.7)	0.9	+
Phosphoric Acid Production	NC	NC	NC	NC	NC	NC	NC
Petrochemical Production	NC	NC	NC	NC	NC	NC	NC
Silicon Carbide Production and Consumption	0.3	0.2	0.1	0.1	0.1	0.1	0.1
Lead Production	NC	NC	NC	NC	NC	NC	NC
Zinc Production	NC	NC	NC	NC	NC	NC	+
Net CO_2 Flux from Land Use, Land-Use Change, and Forestry	*197.4*	*(213.6)*	*4.8*	*2.5*	*(41.3)*	*(36.7)*	*(44.8)*
International Bunker Fuels[b]	*0.2*	*+*	*(0.2)*	*(0.3)*	*(0.4)*	*(0.4)*	*2.7*
Wood Biomass and Ethanol Consumption[b]	*2.6*	*(5.1)*	*1.5*	*2.7*	*10.0*	*7.5*	*13.6*
CH_4	**(9.0)**	**(10.3)**	**(3.3)**	**(12.6)**	**(10.1)**	**(15.1)**	**(16.5)**
Stationary Combustion	0.2	(0.3)	0.1	0.2	0.6	0.5	0.7
Mobile Combustion	+	+	+	(0.1)	(0.1)	(0.2)	(0.2)
Coal Mining	+	0.7	(0.4)	+	(0.5)	(2.8)	(1.8)
Abandoned Underground Coal Mines	NC	NC	0.1	0.1	0.1	0.1	0.1
Natural Gas Systems	(2.3)	+	(0.1)	(0.2)	(0.4)	(1.0)	0.2
Petroleum Systems	+	+	+	+	+	(0.1)	(0.3)
Petrochemical Production	(0.3)	(0.4)	(0.5)	(0.4)	(0.4)	(0.4)	(0.5)
Silicon Carbide Production and Consumption	NC	NC	NC	NC	NC	NC	NC
Iron and Steel Production	NC	NC	NC	NC	NC	NC	NC
Ferroalloy Production[a]	+	+	+	+	+	+	+
Enteric Fermentation	(2.2)	(2.4)	(2.2)	(2.2)	(2.1)	(2.1)	(2.1)
Manure Management	(0.3)	(1.0)	0.7	1.3	1.8	1.3	0.3
Rice Cultivation	NC	NC	NC	NC	NC	+	+
Field Burning of Agricultural Residues	+	+	+	+	+	+	+
Forest Land Remaining Forest Land[a]	7.1	4.0	14.0	6.0	10.4	8.1	6.9
Landfills	(11.3)	(6.2)	(7.1)	(8.5)	(9.4)	(7.5)	(8.8)

Wastewater Treatment	+	(4.8)	(7.9)	(8.8)	(10.0)	(11.0)	(11.3)
International Bunker Fuels[b]	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	+
N_2O	**87.1**	**30.0**	**83.6**	**89.7**	**71.9**	**73.8**	**58.6**
Stationary Combustion	+	(0.1)	+	+	0.2	0.1	0.2
Mobile Combustion	0.3	0.3	0.1	(0.2)	(0.4)	(1.0)	(1.6)
Adipic Acid Production	NC	NC	NC	NC	NC	NC	NC
Nitric Acid Production	NC	NC	NC	NC	+	NC	(0.6)
Manure Management	(7.6)	(8.1)	(8.3)	(8.3)	(8.3)	(8.2)	(8.3)
Agricultural Soil Management	100.8	45.3	98.6	106.0	88.3	91.0	77.3
Field Burning of Agricultural Residues	+	+	+	+	+	+	+
Wastewater Treatment	(6.5)	(7.3)	(7.9)	(8.0)	(8.0)	(8.0)	(8.1)
N_2O Product Usage	NC	NC	NC	NC	(0.5)	(0.5)	(0.5)
Municipal Solid Waste Combustion	NC	NC	NC	+	+	+	+
Settlements Remaining Settlements	(0.5)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.5)
Forest Land Remaining Forest Land	0.7	0.4	1.4	0.6	1.0	0.8	0.7
International Bunker Fuels[b]	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*	+
HFCs, PFCs, and SF_6	**(1.4)**	**8.6**	**9.1**	**8.9**	**10.3**	**11.6**	**10.9**
Substitution of Ozone Depleting Substances	(0.1)	8.1	9.7	9.9	10.7	12.0	11.2
Aluminum Production	0.1	(0.1)	(0.4)	(0.5)	+	+	+
HCFC-22 Production	NC	NC	NC	NC	NC	NC	NC
Semiconductor Manufacture	NC	NC	NC	NC	NC	NC	NC
Electrical Transmission and Distribution	(1.5)	0.6	(0.1)	(0.3)	(0.2)	(0.2)	(0.2)
Magnesium Production and Processing	NC	NC	(0.2)	(0.2)	(0.2)	(0.1)	(0.1)
Net Change in Total Emissions[b]	**133.1**	**87.7**	**165.0**	**134.0**	**149.0**	**145.3**	**129.5**
Percent Change	**6.4%**	**-2.1%**	**2.7%**	**2.2%**	**1.8%**	**1.8%**	**1.3%**

+ Absolute value does not exceed 0.05 Tg CO_2 Eq. or 0.05 percent.
NC (No Change)
[a] New source category relative to previous inventory.
[b] Excludes net CO_2 flux from Land Use, Land-Use Change, and Forestry, and emissions from International Bunker Fuels and Wood Biomass and Ethanol Consumption.
Note: Totals may not sum due to independent rounding.

Table 10-2: Revisions to Net Flux of CO_2 to the Atmosphere from Land Use, Land-Use Change, and Forestry (Tg CO_2 Eq.)

Component: Net CO_2 Flux From Land Use, Land-Use Change, and Forestry	**1990**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**
Forest Land Remaining Forest Land	174.9	(228.9)	(7.7)	(11.7)	(53.5)	(51.2)	(60.1)
Cropland Remaining Cropland	5.0	(11.0)	(10.4)	(10.3)	(10.3)	(9.6)	(10.4)
Land Converted to Cropland	7.2	10.0	10.0	10.0	10.0	10.0	10.0
Grassland Remaining Grassland	4.6	8.8	8.8	8.9	8.9	8.9	8.9
Land Converted to Grassland	3.1	4.8	4.8	4.8	4.8	4.8	4.8
Settlements Remaining Settlements	25.7	15.7	7.7	9.5	7.6	9.4	10.9
Other	(23.0)	(13.0)	(8.5)	(8.6)	(8.9)	(9.0)	(8.9)
Net Change in Total Flux	**197.4**	**(213.6)**	**4.8**	**2.5**	**(41.3)**	**(36.7)**	**(44.8)**
Percent Change	**21.7%**	**-34.7%**	**0.6%**	**0.3%**	**-5.4%**	**-4.7%**	**-5.7%**

+ Absolute value does not exceed 0.05 Tg CO_2 Eq. or 0.05 percent.
NC (No Change)
Note: Numbers in parentheses indicate a decrease in estimated net flux of CO_2 to the atmosphere, or an increase in net sequestration.
Note: Totals may not sum due to independent rounding.